CONE BEETLES OF THE GENUS CONOPHTHORUS IN CALIFORNIA

(Coleoptera: Scolytidae)[1]

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Beetles of the genus *Conophthorus* characteristically attack and kill pine cones in which the broods are produced and the species perpetuated. The species in this group of beetles appear to be restricted to North America as there are no records of *Conophthorus* from Europe, Asia, or South America. Schwarz, in 1895, was the first to describe a species in this group as *Pityophthorus coniperda* from the cones of the eastern white pine, *Pinus strobus* L. Hopkins (1915) described the remainder of the presently recognized species, designating *coniperda* as the genotype.

Hopkins separated his species of *Conophthorus* primarily on the basis of host. However, this study demonstrated that at least three of the six species can be reared from egg to adult on cone tissues other than the selected host (Table I).

The gallery made by the attacking parent adult beetle falls into one of two classes, depending upon the type of host cone. Those cones which have a peduncle, such as sugar pine, western white pine, are attacked in the peduncle or stem of the cone, while those cones which are sessile, such as ponderosa pine, lodgepole pine, or monterey pine, are attacked in the base of the cone proper.

Attack of the cone is made by the female beetle, the male joins the female at a later date and apparently does little in constructing the gallery. Copulation probably occurs within the cone, after which the male leaves or dies within the cone. The cone is killed soon after entrance by the beetle; the gallery may consist of a simple mine in the center of the cone stem or a spiral gallery girdling the axis of the cone where there is no peduncle. After entering and killing the cone, the female extends her gallery parallel with and adjacent to the axis of the cone and not through the axis of the cone as suggested by Keen (1958) and Chamberlin (1958). The eggs are deposited in niches made in the seeds contiguous to the main gallery, usually two to each seed. Upon eclosion, the larvae feed first upon the seed in which the eggs have been deposited and then feed indiscriminately on adjacent cone tissues, destroying much of the interior of the cone.

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The adult female attacks one-year old cones in the spring. Pine cones require two years to mature. An attacked cone may be recognized by the presence of a pitch mass at the entrance hole in the peduncle or cone base. The eggs hatch in a few days following oviposition and the larvae complete development in about two weeks. The mature larva prepares a pupal cell between two scales or in the cone axis and pupates. The pupal period lasts about a week and the teneral adult period about a week. Depending on the species, mature adults may overwinter in this brood cone one or more seasons, may emerge and mine twig tips of the host, overwintering there, or may attack other cones. Details of individual species behavior is discussed below.

The egg first deposited is ovoid in shape and hyaline, turning milky white as the embryo develops. The head capsule of the larva is evident just prior to eclosion. The average size is 1.00 mm long and 0.60 mm wide, with minor variations depending on the species.

The larva is a typical scolytoid, legless larva with a distinct light brown head capsule, the remainer milky-white. Head capsule measurements and rearing studies indicate that there are only two instars (Table 2).

The pupa is white when newly formed and as it matures the mandibles, eyes, and tips of the elytra are the first to darken.

The mature adult is a shiny, cylindrical beetle with short, erect, sparsely-placed hairs on the elytra and pronotum. The elytra are striate-punctate with interstrial punctures generally smaller and

Table 1. Laboratory Rearings of *Conophthorus* eggs on unnatural host cone material.

Species of Beetle	Normal Host	Laboratory Host
C. lambertianae	*Pinus lambertiana Dougl.*	*Pinus pondorosa Laws* *Pinus attenuata Lemm.*
C. ponderosae	*Pinus pondorosa*[3] *Laws.*	*Pinus radiata D. Don* *Pinus lambertiana Dougl.* *Pinus radiata D. Don*
C. radiatae	*Pinus radiata D. Don*	*Pinus lambertiana Dougl.* *Pinus attenuata Lemm.* *Pinus ponderosa Laws.*

[3] *P. attenuata* was not used in this series as there are field collection records of *C. ponderosae* breeding in the cones of *P. attenuata.*

more sparsely placed than those of the striae. An elytral declivity is present but often poorly defined. The head is not visible from above and the anterior portion of the pronotum is granulose with the granules becoming punctures toward the posterior. The color varies slightly between species and at times within species, making color an unreliable character for species separation.

Little information is available on the parasites of bark beetles. Only one larval parasite was recovered during this study, a small bethylid wsp, *Cephalonomia utahensis* Brues (Ruckes, 1956). This parasite was found in all California *Conophthorus* species with the exception of *C. monticolae*. A chalcid parasite, *Tomicobia tibialis* Ashmead, was recovered from the overwintering adults of *C. lambertianae*.

Table 2. Larval Instar Head Capsule Widths.

Species[4]	Instar	Range in mm.	Average in mm.
C. radiatae	I	.336 - .424	.382
	II	.552 - .683	.612
C. ponderosae	I	.372 - .442	.419
	II	.629 - .714	.669
C. lambertianae	I	.340 - .425	.383
	II	.493 - .697	.627
C. monophyllae	I	.368 - .440	.404
	II	.618 - .701	.659

[4] *C. contortae* and *C. monticolae* omitted due to insufficient material.

Unidentified nematodes have been recovered from the Malpighian tubules in the larvae of *C. ponderosae, C. lambertianae,* and *C. monophyllae* and also in the body cavities of the adult beetles. It has not been determined what role these organisms play in the biology of the cone beetles.

Miller (1915) reporting on *C. lambertianae* states: "In many of the cones the brood reaches the stage of full-grown larvae, pupae, or even new adults, and then dies. On an area near Sisson[5], Calif., in 1913, over 50 per cent of the cones contained dead broods. On one area near Colestin, Oreg., in 1914, the brood developed in only 57 per cent of the attacked cones. The mortality of the developed broods amounted to 62 per cent, so broods finally successful in but 21.6 per cent of cones attacked. While the cause appeared to be an entomophagous fungus it has not yet been reported definitely." A similar high incidence of brood mortality had been ob-

[5] Now Mt. Shasta City

served during several years throughout California. No evidence of disease was found in 1956 or 1957 in broods which suffered this high mortality.[6]

Experiments were conducted in 1958 to determine the temperatures attained in aborted sugar pine cones. Thermocouples were inserted into cones *in situ* and on the ground and the temperature was recorded on a 16-point recording potentiometer. While the data were limited to a few days observations, it was then determined that cones in full sunlight on the ground for four hours during the middle of the day were heated to 125-130° F. As brief exposure to temperatures of 115-120° F will kill western pine beetle (Miller, 1931) it is possible that the high brood mortalities found were caused by extreme high temperatures.

Mortality appears to occur when the aborted cones are on the ground as no cones containing dead broods were collected from trees.

A Key to the California Species of Conophthorus Hopkins

(Adult Characters)

1. Elytral declivity with striae 1, 2, and 3 punctured and parallel; declivity slightly impressed, interspace 1 feebly granulate, interspace 3 punctate with each punctate surrounded by a raised annulus ..... *C. monophyllae* Hopkins

   Elytral declivity with striae 1 not punctured or feebly so, striae 2 and 3 punctured, with 2 approaching 3 at apex of declivity and forming the lateral margins of the declivity. Interspace 2 feebly or obviously granulate. Interspace 3 annulate-punctate 2

2. Elytra with punctures of striae 1 and 2 interspace 2 of equal size. Declivity slightly impressed ..... *C. ponderosae* Hopkins

   Elytra with punctures of interspace 2 obviously smaller than the punctures of striae 1 and 2 3

3. Elytra with distinct and parallel rows of strial punctures on lateral area; declivity strongly impressed, punctures of stria 2 in declivity numerous and close together, granules of interspace 1 lacking or very faint ..... *C. lambertianae* Hopkins

   Elytra with strial punctures in obscure rows or confused on lateral area 4

4. Declivity strongly impressed; punctures of striae 2 in declivity numerous and close together, granules of interspace 1 lacking or very faint ..... *C. monticolae* Hopkins

   Declivity slightly impressed or not at all; granules of interspace 1 present and obvious 5

5. Interspace 1 of declivity granulate at apex only ..... *C. contortae* Hopkins

   Interspace 1 of declivity obviously granulate for entire length ..... *C. radiatae* Hopkins

[6] Per communication Dr. E. A. Steinhaus, Dept. Insect Pathology, University of California.

CONOPHTHOREUS MONOPHYLLAE Hopkins

Description.—A black, shining, cylindrical beetle, 3.0 - 3.5 mm long. The elytral declivity with striae 1, 2, and 3 punctured and parallel, with striae 2 passing through the declivity and not forming the lateral margin as in the other California species of *Conophthorus*. This character is suitable for separating this species from the others.

Host.—Singleleaf pinyon, *Pinus monophylla* Torr. & Frem.

Type.—Female, Hopkins 1904. Hopk. U. S. No. 2784, U.S.N.M. Cat. No. 7474.

Type locality.—Ventura County, California.

Distribution.—Probably throughout the range of the host trees.

Seasonal History.—Initial attacks are made early in the spring. Freshly attacked cones were observed during the first week of May, 1956, in Los Angeles County, California, at an elevation of 5000 feet. There appear to be two generations a year as it has been observed that in late fall the smaller cones contain adults and adult emergence holes. The larger cones showed evidence of fresh attack and larva were found in them. However, in cones of all sizes, the overwintering stage is the adult.

CONOPHTHORUS PONDEROSA Hopkins

Description.—A dark brown or black, shining, cylindrical beetle, 3.5—4.2 mm long. Generally the beetles have a black head and pronotum, with reddish brown elytra; however, many specimens have been collected which were totally shiny black. The character which separates this species from the others is the similarity in size of the punctures of striae 1 and 2 and those of interspace 2.

Host.—*Pinus ponderosa* Laws, *P. jeffreyi* Grev. & Balf., *P. washoensis* Mason & Stockwell and rarely the cones of *P. attenuata* Lemmon.

Type.—Female, Sergent 1913. Hopk. U. S. No. 10807a, U.S.N.M. Cat. No. 7479.

Type locality.—Ashland, Jackson County, Oregon.

Distribution.—Commonly throughout the Pacific Coast range of ponderosa pine, occasionally in Jeffrey pine in the Modoc National Forest and eastside Sierra forests, and rarely in *Pinus attenuata* on the northwest California coast in Del Norte County. This species has also been reared from the cones of *Pinus washoensis* in Washoe County, Nevada, adjacent to the California border.

Seasonal History.—The adult attacks on the cones occur during the middle of May and extend into late June. Upon completion of the gallery and egg deposition, the female turns around and leaves the cone by the entrance hole. The entrance hole is then plugged with frass. The behavior of the female after leaving the cone has not been determined. Additional attacks on other cones may occur, or the beetle may die. Brood development is complete by the end of July. The brood adults remain in the cone for the remainder of the season and overwinter in this stage. There appears to be only one generation a year. Living adults were recovered in 1958 from cones attacked in 1956, indicating that some brood adults remain in the brood cone for more than one year. This suggests a possible means of survival during years of poor or non-existent cone crops.

CONOPHTHORUS LAMBERTIANAE Hopkins

Description.—A black, shining, cylindrical beetle. 3.0—4.5 mm long, rarely with reddish-brown elytra. The well-defined and parallel rows of strial punctures on the lateral areas of the elytra separate this species from the others found in California.

Host.—Sugar pine, *Pinus lambertiana* Douglas. Keen (1958) reports that the twigs and cones of *Pinus monticola* Douglas are attacked by this beetle.

Type.—Female, Sergent 1913. Hopk. U. S. No. 10833a2, U.S.N.M. Cat. No. 7478.

Type locality.—Hilt, Siskiyou County, California.

Distribution.—Throughout the range of sugar pine in Oregon and California.

Seasonal history.—Beetle attack occurs during the spring, the time varying from early May to mid-June (Table 3).

Two generations of beetles may occur during heavy cone crop years. Usually, however, the brood adults leave the cones after maturation and mine the twig tips of adjacent sugar pines, overwintering there (Ruckes, 1957).

Table 3. Beetle emergence and first appearance of aborted cones in California 1956-58.

Emergence from cages cones	First appearance of aborted cones	Location
V-7-56	V-16-56	Pinecrest, Tuolumne Co.
V-24-57	VI-2-57	Pinecrest, Tuolumne Co.
no data	VI-12-57	Miami R. S., Mariposa Co.
no data	VI-19-57	Hat Creek, Lassen Co.
VI-8-58	VI-19-58	Pinecrest, Tuolumne Co.

CONOPHTHORUS MONTICOLAE Hopkins

Description.—A shining, cylindrical, beetle, 3.2—3.8 mm long. Usually with black head and pronotum with reddish-brown or black elytra. The declivity of the elytra is strongly impressed and the punctures of striae 2 in the declivity are numerous and close.

Host.—Western white pine, *Pinus monticola* Don.

Type.—Female, Fromme 1906. Hopk. U. S. No. 6541a, U.S.N.M Cat. No. 7477.

Type locality.—Priest River, Boundary County, Idaho.

Distribution.—Probably throughout the range of western white pine. The species has been collected in Idaho (type locality Priest River), Washington, Montana, western Canada (Cowitchan Lake) and northern California (Lassen Volcanic National Park) (Ruckes, 1959).

Seasonal history.—Nothing is known of the habits of this species. It is assumed that they are similar to other species attacking pedunculate cones, such as *C. lambertianae.*

CONOPHTHORUS CONTORTAE Hopkins

Description.—A black, shining, cylindrical beetle, 2.9—3.5 mm long. The declivity with a few (1-3) granules at the apex.

Host.—Shore pine, *Pinus contorta* Dougl. ex Loud. and lodgepole pine, *P. murrayana* Grev. & Balf. (Ruckes, 1959).

Type.—Female, Hopkins 1899. Hopk. U. S. No. 88. U.S.N.M. Cat. No. 7481.

Type locality.—Newport, Lincoln County, Oregon, in the cone of *Pinus contorta* var. *contorta* Engelm.

Distribution.—Probably throughout the range of the host, but has not been collected from shore pine in California.

Seasonal history.—The observations reported here were made on the beetles in the cones of the lodgepole pine which occurs at higher elevation where there is a shorter growing season. Beetle flight and attack occurs in late June and July after the snow has melted from the ground. The pupa is the overwintering stage. Development in shore pine was not observed.

CONOPHTHORUS RADIATAE Hopkins

Description.—A black, shiny, cylindrical beetle, 3.1—4.1 mm long. The declivity of the elytra is slightly impressed and interspace 1 of declivity has many granules the length of each interspace.

Host.—Monterey pine, *Pinus radiata* Don.

Type.—Female, Miller 1913. Hopk. U. S. No. 10861a. U.S.N.M. Cat. No. 7481.

Type locality.—Pacific Grove, Monterey County, California.

Distribution.—This species has only been collected from the type locality but probably occurs throughout the host range.

Seasonal history.—The attack and oviposition habits are similar to the other species of cone beetles which attack sessile cones. Adult beetles attack the green developing second-year cones in the spring and oviposit in them. Development is complete by fall and they may overwinter in the brood cone or they may emerge and enter first-year conelets to overwinter. One generation of beetles completed development in 44 days under laboratory conditions.

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